

REMARKS

The Office Action dated May 2, 2008 has been received and carefully noted. The above amendments to the claims, and the following remarks, are submitted as a full and complete response thereto.

Claims 11, 19, and 24 have been amended to more particularly point out and distinctly claim the subject matter of the invention. Claim 23 has been cancelled without prejudice or disclaimer. New claim 25 has been added. Support for new claim 25 can be found in the specification, for example, at paragraph 0060. No new matter has been added. Therefore, claims 1-19 and 24-25 are currently pending in the application and are respectfully submitted for consideration.

The Office Action's comments regarding the Information Disclosure Statement, filed on November 9, 2006, have been noted.

The Office Action rejected claims 1, 2, 4-7, 9, 11, 13-16, 18, 23, and 24 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2005/0013347 ("Pan") in view of U.S. Patent Publication No. 2008/0018533 ("Van Wechel"), and further in view of U.S. Patent Publication No. 2002/0154716 ("Erving"). The Office Action took the position that Pan discloses all the elements of the claims with the exception of "computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix," "estimating interference from a

received signal at a second observation time and determining additional covariance components on the basis of the estimation,” and “creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations.” The Office Action then cited Van Wechel and Erving as allegedly curing the deficiencies of Pan. (see Office Action at pages 3-5). The rejection is respectfully traversed for at least the following reasons.

Claim 1, upon which claims 2-10 are dependent, recites a method, which includes estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix, and removing selected covariance components from the Cholesky decomposition matrix. The method further includes computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix, and estimating interference from a received signal at the second observation time and determining additional covariance components on the basis of the estimation. The method further includes creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations, and generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

Claim 11, upon which claims 12-19 are dependent, recites an apparatus, which includes a first estimator configured to estimate interference from a received signal at a first observation time, create a first covariance matrix on the basis of the estimation and define an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix, and a remover configured to remove selected covariance components from the Cholesky decomposition matrix. The apparatus further includes a processor configured to compute the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix, and a second estimator configured to estimate interference from a received signal at the second observation time and determine additional covariance components on the basis of the estimation. The apparatus further includes a creator configured to create the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations, and a first generator configured to generate an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

Claim 24 recites an apparatus, which includes first estimating means for estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix, and removing means for

removing selected covariance components from the Cholesky decomposition matrix. The apparatus further includes computing means for computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix, and second estimating means for estimating interference from a received signal at a second observation time and determining additional covariance components on the basis of the estimation. The apparatus further includes creating means for creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations, and generating means for generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

Claim 25 recites a computer program, embodied on a computer-readable medium, configured to control a processor to implement a method. The method includes estimating interference from a received signal at a first observation time, creating a first covariance matrix on the basis of the estimation and defining an inverse matrix of the first covariance matrix and a Cholesky decomposition matrix, and removing selected covariance components from the Cholesky decomposition matrix. The method further includes computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition

of the inverse matrix of the first covariance matrix, and estimating interference from a received signal at the second observation time and determining additional covariance components on the basis of the estimation. The method further includes creating the Cholesky decomposition of the inverse matrix of the second covariance matrix by using unitary rotations, and generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix.

As will be discussed below, the combination of Pan, Van Wechel, and Erving fails to disclose or suggest all of the elements of the claims, and therefore fails to provide the features discussed above.

Pan generally discloses that symbols are to be recovered from signals received in a shared spectrum. Codes of the signals received in the shared spectrum are processed using a block Fourier transform (FT), producing a code block diagonal matrix. A channel response of the received signals is estimated. The channel response is extended and modified to produce a block circulant matrix and a block FT is taken, producing a channel response block diagonal matrix. The code block diagonal matrix is combined with the channel response block diagonal matrix. The received signals are sampled and processed using the combined code block diagonal matrix and the channel response block diagonal matrix with a Cholesky algorithm. A block inverse FT is performed on a result of the Cholesky algorithm to produce spread symbols. The spread symbols are de-spread to recover symbols of the received signals. (see Pan at Abstract).

Van Wechel generally discloses a system for filtering interfering signals in a front end of a GPS receiver. A GPS receiver includes a space-time adaptive processing filter. At least a portion of the interfering signals are removed by applying weights to the inputs. The weights are adaptively calculated and applied by Fourier Transform convolution and Fourier Transform correlation. The Fourier Transform is computed via a Fast Fourier Transform. (see Van Wechel at Abstract).

Erving generally discloses an algorithm for computing an efficient, reduced complexity, windowed optimal linear time domain equalizer for a dispersive channel. The algorithm includes the steps of determining a window of maximum energy in the impulse response of length equal to or less than a number of cyclic prefix samples associated with a received digital data signal and computing the corresponding inside and outside matrices. The algorithm also includes performing an inverse Cholesky decomposition of the inside matrix, creating a resultant matrix as the product of the outer and the upper and lower square root inner matrix, followed by Householder reduction and QL transformation to thereby compute the time domain equalizer as the linear transformation of the eigenvector corresponding to the smallest eigenvalue at the receiver. The smallest eigenvalue is determined using the aforementioned orthogonal transformations without determining all the eigenvalues efficiently but without the loss accuracy associated with iterative methods like the conventional power method. (see Erving at Abstract).

Applicants respectfully submit that Pan, Van Wechel, and Erving, whether considered individually or in combination, fail to disclose, teach, or suggest, all of the elements of the present claims. For example, the combination of Pan, Van Wechel, and Erving fails to disclose, teach, or suggest, at least, *“computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix,”* and *“generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix,”* as recited in independent claim 1, and similarly recited in independent claims 11, 24, and 25.

The Office Action took the position that Pan discloses *“generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix,”* as recited in independent claim 1, and similarly recited in independent claims 11, 24, and 25. (see Office Action at page 3). Applicants respectfully submit that the Office Action’s position is incorrect.

Pan discloses that a calculation of an estimated spread signal \hat{s} by taking the conjugate of block diagonal matrix Λ_H , producing Λ_H^* , multiplying the result of backward substitution to Λ_H^* , and taking a block inverse Fourier Transform of the result. (see Pan at paragraph 0056). Pan is silent as to generating or inverting a second

covariance matrix. Thus, Pan fails to disclose, or suggest, discloses “*generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix,*” as recited in independent claim 1, and similarly recited in independent claims 11, 24, and 25.

Furthermore, as the Office Action correctly concluded, Pan also fails to disclose, or suggest, “*computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix,*” as recited in independent claim 1, and similarly recited in independent claims 11, 24, and 25. (see Office Action at pages 3-4).

Furthermore, Van Wechel and Erving, whether considered individually or in combination, fail to cure the deficiencies of Pan.

The Office Action took the position that Van Wechel discloses computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix. (see Office Action at page 4). Applicants respectfully submit that the Office Action’s position is incorrect.

As described above, Van Wechel discloses a method and signal processor for calculating a sub-matrix of a covariance matrix of a Global Position System space-time adaptive processing filter. The sub-matrix is calculated by calculating at least one row of the sub-matrix and copying at least one value from the calculated row to another position.

(see Van Wechel at paragraphs 0014-0015). Van Wechel is silent as to computing the inverse of a sub-matrix.

Furthermore, Van Wechel discloses STAP covariance matrices for a 3-element antenna array and for a 7-element antenna array, respectively. A covariance matrix includes a number of unique sub-matrices, where the number depends on the number of elements in the antenna array. Furthermore, a sub-matrix can be calculated by taking the complex conjugate of some other sub-matrix. (see Van Wechel at paragraphs 0072-0073). However, Van Wechel is silent as to the sub-matrix representing the common part of the first covariance matrix and a second covariance matrix.

The Office Action further took the position that Van Wechel discloses that the second covariance matrix would include covariance estimates of a second observation time. (see Office Action at page 4). However, it appears that the Examiner did not refer to any particular part of Van Wechel in discussing this limitation. Applicants respectfully submit that this position is also incorrect. Van Wechel merely discloses the presence of Cholesky decomposition for matrix inversion. (see Van Wechel at paragraph 0099). Van Wechel is silent about a second covariance matrix including covariance estimates of a second observation time.

Finally, the Office Action took the position that Van Wechel discloses computing the inverse of a submatrix by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix. (see Office Action at page 4). Applicants respectfully submit that this position is also incorrect.

Van Wechel merely discloses some general matrix properties of covariance matrices which can be used in computing the inverse of a covariance matrix. Specifically, Van Wechel discloses that the covariance matrix of a STAP filter corresponds to a Hermitian matrix, where the Hermitian matrix is equal to the conjugate transpose of the matrix. Van Wechel is silent as to computing the inverse of a sub-matrix by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix.

Regarding Erving, the Office Action took the position that Erving discloses computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix. (see Office Action at page 4). Applicants respectfully submit that this position is incorrect.

Erving discloses an inner A matrix and an outer B matrix which together form a matrix as the product of the outer matrix A and the inverse of the “square root” lower triangle matrix of the inner matrix B. Furthermore, the “square root” lower and upper triangular matrices of the inner matrix are obtained by Cholesky decomposition. However, Erving is silent as toward the inverse of the sub-matrix representing the common part of a first covariance matrix and a second covariance matrix, and is silent as towards covariance estimates of a second observation time.

Therefore, for at least the reasons discussed above, the combination of Pan, Van Wechel, and Erving fails to disclose, teach, or suggest, all of the elements of independent claims 1, 11, 24, and 25. For the reasons stated above, Applicants respectfully request that this rejection be withdrawn.

Claims 2, 4-7, and 9 depend upon independent claim 1. Claims 13-16 and 19 depend upon independent claim 11. Thus, Applicants respectfully submit that claims 2, 4-7, 9, 13-16, and 19 should be allowed for at least their dependence upon independent claims 1 and 11, respectively, and for the specific elements recited therein.

The Office Action rejected claims 3 and 12 under 35 U.S.C. § 103(a) as being unpatentable over Pan in view of Van Wechel, and further in view of Erving as applied to claims 1 and 11, and further in view of U.S. Patent No. 7,113,540 (“Yousef”). The Office Action took the position that the combination of Pan, Van Wechel, and Erving discloses all the elements of the claims with the exception of “the Cholesky decomposition of the inverse matrix of the first covariance matrix of the specific form (described in equation 3 of specification paragraph 0035).” The Office Action then cited Yousef as allegedly curing the deficiencies of Pan, Van Wechel, and Erving. (see Office Action at pages 7-8). The rejection is respectfully traversed for at least the following reasons.

The descriptions of Pan, Van Wechel, and Erving, as discussed above, are incorporated herein. Yousef discloses that Multi-Input-Multi-Output (MIMO) Optimal Decision Feedback Equalizer (DFE) coefficients are determined from a channel estimate

h by casting the MIMO DFE coefficient problem as a standard recursive least squares (RLS) problem and solving the RLS problem. (see Yousef at Abstract).

Claims 3 and 12 depend upon independent claims 1 and 11, respectively. As discussed above, the combination of Pan, Van Wechel, and Erving does not disclose, teach, or suggest all of the elements of independent claims 1 and 11. Furthermore, Yousef does not cure the deficiencies in Pan, Van Wechel, and Erving, as Yousef also does not disclose, teach, or suggest, at least, *“computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix,”* and *“generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix,”* as recited in independent claim 1, and similarly recited in independent claims 11, 24, and 25. Thus, the combination of Pan, Van Wechel, Erving, and Yousef does not disclose, teach, or suggest all of the elements of claims 3 and 12. Additionally, claims 3 and 12 should be allowed for at least their dependence upon independent claims 1 and 11, and for the specific elements recited therein.

The Office Action rejected claims 8, 10, 17, and 19 under 35 U.S.C. § 103(a) as being unpatentable over Pan in view of Van Wechel, and further in view of Erving as applied to claims 1 and 11, and further in view of U.S. Patent No. 6,622,117 (“Deligne”). The Office Action took the position that the combination of Pan, Van Wechel, and Erving

discloses all the elements of the claims with the exception of “the Cholesky factorization of the inverse matrix of the second covariance matrix as in equation 8, paragraph 0047 of the specification,” with respect to claims 8 and 17, and “the output value of the channel equalize is generated by further utilizing a-priori symbol estimate information,” with respect to claims 10 and 19. The Office Action then cited Delinge as allegedly curing the deficiencies of Pan, Van Wechel, and Erving. (see Office Action at pages 8 and 9). The rejection is respectfully traversed for at least the following reasons.

The descriptions of Pan, Van Wechel, and Erving, as discussed above, are incorporated herein. Deligne discloses expectation-maximization equations to iteratively estimate un-mixing filters and source density parameters in the context of Convolutional Independent Component Analysis (CICA) where the sources are modeled with mixtures of Gaussians, a scheme to estimate the length of the un-mixing filters, and two alternative schemes to initialize the algorithm. (see Deligne at Abstract).

Claims 8, 10, 17, and 19 depend upon independent claims 1 and 11, respectively. As discussed above, the combination of Pan, Van Wechel, and Erving does not disclose, teach, or suggest all of the elements of independent claims 1 and 11. Furthermore, Deligne does not cure the deficiencies in Pan, Van Wechel, and Erving, as Deligne also does not disclose, teach, or suggest, at least, *“computing the inverse of a sub-matrix, which represents the common part of the first covariance matrix and a second covariance matrix, which includes covariance estimates of a second observation time, by using the aid of the Cholesky decomposition of the inverse matrix of the first covariance matrix,”*

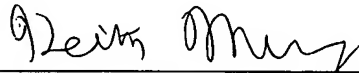
and “*generating an output value of the channel equalizer by utilizing information obtained with the aid of the Cholesky decomposition of the inverse matrix of the second covariance matrix,*” as recited in independent claim 1, and similarly recited in independent claim 11. Thus, the combination of Pan, Van Wechel, Erving, as Delinge does not disclose, teach, or suggest all of the elements of claims 8, 10, 17, and 19. Additionally, claims 8, 10, 17, and 19 should be allowed for at least their dependence upon independent claims 1 and 11, respectively, and for the specific elements recited therein.

For at least the reasons discussed above, Applicants respectfully submit that the cited prior art references fails to disclose or suggest all of the elements of the claimed invention. These distinctions are more than sufficient to render the claimed invention unanticipated and unobvious. It is therefore respectfully requested that all of claims 1-19 and 24-25 be allowed, and this application passed to issue.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicants' undersigned representative at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,



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